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Physical Dissertation,

CONCERNING

The Cause of the VARIATION of the BAROMETER, the Form of the GLOBE of the EARTH, the Diminution of HEAVY BODIES, the Flux and Reflux of the SEA; wherein some MISTAKES in Sir *ISAACK NEWTON*'s *System* are rectify'd.

As also, that it is impossible to find out the

LONGITUDE;

And that those who pretend to make that Discovery, are Impostors.

Written Originally in *French* by the Sieur *Jaques de Roubais du Tourcoin*, and publish'd by Monsieur *S. Dury de Champdere*, now Engineer to their High Mightinesses, the Lords, the States-General of the *United Provinces*.

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Phyſical Diſſertation, &c.

CHAP. I.

The Cauſe of the Variation of the Barometer.

HAVING been for a long Time employ'd in Buildings of ſeveral Sorts, Fortifications of Places, as alſo in the Management of Water-Courſes; I had frequent Opportunities of obſerving and finding out in theſe Works a great many ill Deſigns, ſeveral Things ill underſtood and ill order'd, and Undertakings ſo ill concerted, that I could not but be ſurpriz'd, and pity the Ignorance of thoſe who built, order'd, or directed them.

Upon making a ſerious Reflection on the Faults which I have obſerv'd in theſe Works, and knowing the Cauſe, I fram'd to my ſelf a Deſign to employ the little Leiſure-Time I

ſhould be Maſter of, to compoſe a Treatiſe of *Hydraulicks*, as well as on all the Works which depend upon it, intending then to preſent it to the Publick; believing a Treatiſe of this Nature would be very neceſſary: Becauſe, tho' the World at preſent is ſo full of Books, that they almoſt ſurfeit one, yet we do not ſee ſo much as one that treats of the true Principles of this Art, which is the Cauſe that theſe Principles are entirely unknown to the Majority of thoſe who are entruſted with the Care and Direction of Water-Courſes, whether to make Rivers navigable, or practiſe Inundations: Nor are theſe Principles of ſo noble an Art more underſtood by thoſe who undertake Buildings, which often require great Precautions, that cannot be had, but by knowing, and by being very particularly inſtructed in a great many Things.

It is no difficult Matter to comprehend, that it is to mere Ignorance and Want of Inſtruction, to which we ought to attribute all the Faults that are committed by the Orderers, Directors, or Undertakers of theſe Sorts of Works, which are often found to be ſo ill contriv'd and built up, as to fall down before they are finiſh'd; which has been very often ſeen in ſeveral Places, to the great Damage and Prejudice of thoſe Potentates who have been at the Expence of them, as well as to the Shame and Confuſion of the Directors and Undertakers.

Having made theſe Reflections, I believ'd it would be of Advantage to the Publick to compoſe a Treatiſe on this Subject; but not being a Man of Letters, nor uſed to write, it was no eaſy Thing for me to lay open my Thoughts in ſuch a Manner as might be agreeable

able to every one's Taſte, or to explain them in ſuch a pleaſant and polite Stile, as may render them acceptable to the Learned of this preſent Age, which is partly the Cauſe that ſuch Treatiſe has not yet appear'd. Beſides, it will be of ſuch Bulk, and full of ſo many Figures, that the Expence for its Impreſſion would be a little too great for the Purſe of a private Man, as I am, or even that of a Book-ſeller; for I can find not one of that Profeſſion in the Humour of advancing ſo great a Sum as is neceſſary; ſo that this Treatiſe runs the Riſque of never ſeeing the Light, unleſs ſome Prince, or Potentate, that has an Inclination to favour Science, will largely contribute towards the Expence of the Impreſſion; from whence the Publick, and particularly the Powers intereſted in Commerce and Navigation, might reap conſiderable Profit and Advantage.

The Reaſon why this Work has ſwell'd to ſuch a Bulk, is this: Being ſatisfy'd, that all thoſe who make Profeſſion of *Hydraulicks*, ought, of Neceſſity, to know the Principles of *Phyſicks*, I was oblig'd to add to my Treatiſe ſuch of thoſe Principles, which are of abſolute Neceſſity to be known, and which thoſe who make Profeſſion of this Art, can by no Means paſs by; ſuch, for Example, as the Principles of Motion in Water. This alſo has oblig'd me to explain the Cauſe of the Flux and Reflux of the Sea, according to the Syſtem of *Des Cartes*, which has been follow'd by a great many other Philoſophers, and which appear'd to me to be more natural, and more agreeable to Truth, than what has been publiſh'd by any other Philoſopher.

This Syſtem, as every one knows, attributes the Cauſe of the Flux and Reflux of the Sea, to a certain Preſſure of the Moon on the Globe of the Earth, and on the Surface of the Sea, in paſſing thro' the Meridians, that puſhes the Waters of the Sea out of the Place they were in, which return to their former Situation, after the Moon has paſt by.

But after ſome Reflections hereupon, and finding that this Preſſure was not ſenſible on the Barometer, and that it produc'd no Manner of Variation in the Mercury, which had the leaſt Connection with the Flux and Reflux of the Sea; nor that this is found to be ſo under the Torrid Zone, as methinks it ſhould be, this made me believe, that one of theſe two Things muſt of Neceſſity be the Cauſe, either that this Preſſure of the Moon has its Effect on the Surface of the Waters of the Sea, without communicating itſelf either to the Atmoſphere of the Air, which involves the Earth, or the Mercury in the Barometer: Or elſe, that this Preſſure muſt be ſo little ſenſible, that thoſe who made their Obſervations under the Torrid Zone, could not perceive it by the Barometer. But, perhaps, this was becauſe they made not ſufficient Applications to their Obſervations.

This laſt Conjecture, at firſt View, appear'd to me to be the moſt agreeable to Truth; but after having made ſome Reflection thereupon, I perceiv'd that it involv'd an inſuperable Difficulty, which convinc'd me, that in *Phyſicks* one can ſcarce be aſſur'd of any Thing, and that there are yet a great many more Things to be diſcover'd than we know; and this Difficulty I explain as follows:

I ſuppoſe,

I ſuppoſe, in the firſt Place, that Per hrteſſure of the Moon on the Surface of the Waters of the Sea, to be equal to $\frac{1}{2}$ Line of Mercury, which correſponds to ſeven Lines of Water, at moſt, which, in my Opinion, is the leaſt Preſſure that can be attributed to the Moon, to produce the Flux and Reflux of the Sea, without its being perceiv'd; or, to ſpeak more clearly, without being perceiv'd by the Variation of the Barometer. In the ſecond Place, I ſuppoſe, that the Preſſure of the Weight of the Air, to which we attribute the Variation of the Barometer, cauſes the ſame Effect upon the Surface of the Waters of the Sea, as on that of the Mercury in the Box of the Barometer, which is, I think, what all ought to agree in.

This being ſuppos'd, it is eaſy to ſee, that the irregular Preſſure of the whole Weight of the Air, which makes the Barometer vary to 20 or 24 Portions, muſt be 40 or 50 Times more ſenſible on the Surface of the Sea, than the regular Preſſure of the Moon, which we ſuppoſe to be equal to $\frac{1}{2}$ Line of Mercury under the Torrid Zone. And thence it muſt be concluded, that the irregular Preſſure of the Weight of the Air, which has its Effect on the Surface of the Sea, as well as on that of the Mercury of the Barometer, muſt produce an irregular Flux and Reflux 40 or 50 Times more ſenſible than the ordinary Flux and Reflux which we attributed to the Preſſure of the Moon, which is abſurd: For if we except ſome certain Accumulation of Water produc'd by the Winds, we cannot obſerve the leaſt Thing that bears any Relation to what I have ſaid.

From

From thence, I think, we ſhould conclude, that the Variation of the Barometer ought to be equal all over the Earth; that the Weight of the Air preſſing the Earth on all Sides, may not cauſe any extraordinary Motion in the Waters of the Sea, from the Place where it is moſt preſs'd to that where it is leaſt, as it would be according to the Laws of *Staticks*. But, on the other Hand, when one reflects, that according to the Obſervations which have been made in ſeveral Parts of the Earth, the Variation of the Barometer is greater in one than in another, it appears, I think, that ſuch Uniformity of the Variation of the Barometer is unknown: Beſides, if one makes any Reflection upon the Rolling of the Air, which we obſerve, by means of the Winds, one ſhall find, that there is greater Appearance that this Variation of the Barometer is irregular over all the Air; that is, it riſes in one Place at the ſame Inſtant that it falls in another; which, however, does not hinder, but there may be ſuch a Connection between the Variation of the Barometer and the irregular Motion of the Water in the Sea, as may make one of theſe Effects abſolutely depend on the other.

All theſe Reflections convince me, that if we could but once diſcover the Cauſe of the Variation of the Barometer, we ſhould then be provided of ſure Means of making ſeveral fine Diſcoveries in *Phyſicks*; being entirely perſuaded, that not only the irregular Motions of the Water of the Sea, but alſo Rains, Winds, Tempeſts, Thunder, and other *Phenomena* of Nature, owe their Origin to the ſame Cauſe, which produces the Variation of the Barometer, as I have explain'd in my Treatiſe of *Phyſicks*.

CHAP.

CHAP. II.

A Project of Physical *Observations, concerning the Means how to discover the Cause of the Variation of the Barometer, Winds, and other* Phenomena *of Nature.*

ALL Philosophers agree, that the Cause of the Variation of the Barometer must be attributed to the Weight of the Air; but they do not all agree in the Means by which the Atmosphere of the Air may acquire successively such different kinds of Weight, and which are like those which we observe in the Barometer. Monsieur *Pascal* was of Opinion, that one ought to attribute the Cause to the Vapours, which mingle themselves with the Particles of the Air, and which make it more ponderous. But as we know, by Observation, that the Air is moister and more loaded with Vapours, when the Mercury of the Barometer is lower; and, on the contrary, more dry and less charged with Moisture, when the Mercury is higher; it is evident, that this System is contrary to Experience,

Experience, as Monſieur *Mariotte* has prov'd in his Treatiſe of the Motion of the Water.

Dr. *Halley* thought on another Syſtem, which appears more probable, by attributing to the Winds the Cauſe of the ſucceſſive Augmentations and Diminutions of the Weight of the Air; becauſe the Winds (as he imagines) driving more Air to ſome one Part of the Earth, muſt augment it's Weight, in Proportion as it augments the Quantity; which is natural. And, on the contrary, the ſame Winds, having driven another Portion of Air to ſome other Place, in like manner diminiſhes the Weight, by diminiſhing it's Quantity; and it is to theſe ſucceſſive Augmentations and Diminutions of the Air to which he attributes the Cauſe of the Variation of the Barometer.

It may be objected againſt this Syſtem, that, according to this Hypotheſis, the Air would always move itſelf towards that Place where it was moſt preſs'd, which is contrary to the Laws of Motion in fluid Bodies, which oblige them, on the contrary, to move towards that Place where they are leaſt preſs'd. One may farther object againſt him, that the Winds, which puſh a great Quantity of Vapours towards the Place where the Air gathers itſelf together, muſt there produce Rains and rainy Weather, when the Barometer is at the higheſt Point; and, on the contrary, the faireſt Weather, when the Winds have carry'd the Air away from that Place, where it was moſt compacted, and the Barometer at the loweſt; which is contrary to Experience.

In order to find out a Syſtem conformable to the Rules of *Statics*, and the Laws of Motion

in fluid Bodies, I preſent the Publick with theſe Reaſons following.

One may conjecture two different Ways by which the Atmoſphere of the Air may acquire ſucceſſively different Kinds of Weight, the one of ſucceſſive Augmentations and Diminutions of the ſpecifick Quantity of Matter, and the other by the Augmentation and Diminution of the ſpecifick Weight which the ſame Quantity of Air may ſucceſſively acquire in different Times, as I explain it in my Treatiſe of Phyſicks.

The firſt Conjecture being ſuppos'd as moſt agreeable to Truth, one may conceive two different Ways by which the ſpecifick Quantity of the Air, at a certain Place of the Earth, may be ſucceſſively augmented and diminiſh'd. Firſt, by the rolling of a certain Quantity of Air from one Part of the Earth to another; and, ſecondly, by a total Augmentation or Diminution of the Atmoſphere of the Air, which may be done by ſeveral Ways of Evaporation, as is at large explain'd in my abovemention'd Treatiſe of *Phyſicks*.

On this firſt Conjecture of the rolling of the Air, one may farther conceive two different Ways, by which one Portion of Air may roll itſelf from the Earth to another, that is, through the lower Part of it's Atmoſphere, and, ſecondly, thro' the upper Part; there being no ſolid Reaſon to make us think that the whole Atmoſphere of the Air can move itſelf, Experience aſſuring us the contrary, by making us ſee, by the Motion of the Clouds, that the middle Region of the Air continues calm enough, while it's lower Part is agitated by violent Winds or by the Mo-

tions of the Air, which rolls itſelf from one Part of the Earth to another along it's Surface.

As to the Syſtem of the rolling of the Air, through the lower part of it's Atmoſphere, one cannot doubt of it, after the Experience we every Day make of the ſenſible Force of the Winds. But, on the other Hand, when we reflect on the Cauſe of the Winds, one ſhall have much to do to find one which may naturally produce ſuch violent Effects as thoſe are which we perceive during a furious Tempeſt, except it be this Syſtem of Dr. *Halley*'s which yet is ſubject to the Difficulties above explain'd.

For theſe Reaſons, the other Syſtem, which ſuppoſes the rolling of Part of the Air from one Place of the Earth to another, through the upper Part of the Atmoſphere, appears to me much more likely to be true, and more natural; being agreeable to *Staticks*, and the Laws of Motion in fluid Bodies. But doubting leſt this Syſtem ſhould appear a little ſtrange, by reaſon of it's Novelty, I have explain'd it at it's full Length in my Treatiſe of *Phyſicks*, of which this is the Subſtance.

In the firſt Place, I ſuppoſe the Revolution of the Earth about it's Axis, from Weſt to Eaſt, a Truth which no one doubts of at preſent. In the ſecond Place, I ſuppoſe the Atmoſphere of the Air, which ſurrounds the Globe of the Earth, to be a fluid Body, and of a middle Quality, between the Water, which is below, and the *ſubtile Matter*, which is above it; and this I believe no one will contradict.

This being laid down as a Foundation of the whole Syſtem, I prove, by the Laws of Motion in fluid Bodies, that the daily Revolution of the

the Globe of the Earth, by the meeting of two Bodies of a different Quality, muſt produce, above the Atmoſphere of the Air, certain Motions in the *ſubtile Matter*, and in the Air itſelf, after the ſame Manner as it produces them below the Atmoſphere of the Air, and in the Water of the Sea. I prove, moreover, that theſe Motions under the Torrid Zone are uniform, and that their Force muſt be augmented or diminiſh'd by the Movements of the Moon, and by her Conjunction with other Planets. After this I make it appear, that theſe Motions of the *ſubtile Matter* muſt extend themſelves towards the Poles, from one Part of the Æquator to the other; and how they muſt grow the moſt violent and irregular, in the ſame Manner as the Winds do on the Surface of the Earth. Then I prove, by *Staticks*, and the Laws of Motion in fluid Bodies, that theſe Motions above the Atmoſphere of the Air muſt produce the Variation of the Barometer, Winds, Rains, Tempeſts, and ſeveral other *Phenomena* which we ſee and feel on the Earth; and thence I conclude, that thoſe who fancy'd it impoſſible, that the Planets can have no more Influence upon the Earth than lighted Candles in the middle of an open Field, are much deceiv'd; ſince I evidently ſhew, that they have an Influence over Winds, Rain, and, by Conſequence, over a great many more Things than we think they have.

To explain theſe Effects according to my new Syſtem, I preſuppoſe, that there are in the *ſubtile Matter*, above the Atmoſphere of the Air, certain irregular Motions, (as I obſerve above) which agitate it below the Atmoſphere, puſh it, and make it roll itſelf up together,

ſometimes to one Part of the Earth, ſometimes to another, ſometimes more, and ſometimes leſs, according to their Force and Direction: After the ſame Manner, for Example, as the Winds, or the irregular Motions of the Air, agitate the Surface of the Waters in the Sea, and puſh them on, and make them roll, ſometimes to one Part of the Earth, ſometimes to another, ſometimes with greater Fury, ſometimes with leſs, according to the Force, Duration, and Direction of theſe Winds.

From all which it is eaſy to comprehend, *firſt*, that when theſe ſtrange Motions, above the Atmoſphere of the Air, ſhall puſh a Portion of Air from one Part of the Earth to another, the Barometer muſt ſink at the Place whence the Air was forc'd away; and, on the contrary, muſt riſe at the Place where the Air is thus huddled up together. *Secondly*, that the Air near the Earth, being more preſs'd at the Place where the Air is gather'd together, than at the Place whence it is forc'd away, according to the Laws of *Staticks*, muſt move from the Place where it is more forc'd towards the Place where it is leſs; that is, from the Place where the Barometer is riſen towards that where it is fallen, which muſt be the Cauſe of Winds, that are nothing elſe but the reflowing of the Air from the Place where it was gathered up together to that Place whence it was forc'd away, to furniſh new Matter, or new Air, to theſe ſtrange Motions, in ſuch Manner, that the Air then makes a Circulation, which laſts for no longer a Time than the Cauſe ſubſiſts. It is alſo eaſy to ſee, that the Thing being ſuch as we ſuppoſe it to be, as being

being very probable, one may diſcover, by the Effects it produces on the Earth, in eſtabliſhing in ſeveral Places Obſervators, who may keep Regiſters, or Journals, the moſt exact on the Winds and the Variations of the Barometer, according to the Plan I ſhall herein after inſert.

If all theſe Obſervators find, that the Barometer varies every where after an uniform Manner, one ſhall then know, that the Cauſe of the Variation proceeds from Evaporations, and that ſucceſſively the Air reſolves itſelf into Water, and the Water into Air, as *Deſcartes*, and ſeveral other Philoſophers have explain'd; or elſe diſſipates itſelf in vaſt Spaces, as I explain in my Treatiſe.

If, on the contrary, theſe Obſervators find, as it is very probable, that the Barometer falls in one Part of the Earth, at the ſame Time that it riſes in another, we may be aſſur'd, that the Cauſe of the Variation of the Barometer muſt be attributed to the Rolling of the Air from one Part of the Earth to another: We ſhall likewiſe know, by theſe ſame Obſervations, whether or no this Rolling of the Air is made through the lower Part of the Atmoſphere of the Air, that is, the Winds; or through the upper Part, by Means of ſtrange Motions. For, if one of theſe Obſervators finds that the Barometer is riſen at that Inſtant, when another Obſervator finds it fallen, and that a third, in a Place in the middle between the other two, finds that the Winds blew from the Place where the Barometer fell towards that Place where it roſe, one may then believe that the Rolling of the Air is made at the lower Part

of

of it's Atmoſphere, by the Means of the Winds, according to the Syſtem of *Dr. Halley*. And if, on the contrary, the third Obſervator finds, that at the Times of theſe oppoſite Variations, the Winds blew from the Place where the Barometer was riſen, towards the Place where it was fallen, one ſhall then know that the Rolling of the Air was made at the upper Part of it's Atmoſphere, according to my New Syſtem; and conſequently, that, there are Motions in the *ſubtile Matter*, which agitate and puſh it from one Place to another in the manner as I have here above explain'd. By Means of theſe Obſervators one may farther diſcover ſeveral other *Phenomena* of Nature, as well in the Air as on the Motions of the Waters in the Sea, and their Flux and Reflux, as I have explain'd in my Treatiſe of *Phyſicks*.

CHAP.

CHAP. III.

A Plan of Obſervations.

IT is eaſy to comprehend, by what has been ſaid above, that theſe Obſervations are very ſimple, very eaſy to make, and but of ſmall Expence, there being Occaſion only of one ſimple Barometer for that Purpoſe, which is an Inſtrument very common, and in every Body's Hands; and one has nothing more to do, than to obſerve once or twice a Day the Height of the Mercury, and what Wind blows, and when, which moſt People generally do for their own Satisfaction. I ſhall ſet down the Rules, which, in my Judgment, are neceſſary for theſe Obſervators to guide themſelves by. An exact Regiſter or Journal of theſe Obſervations is abſolutely neceſſary to be kept, wherein muſt be enter'd down, twice every Day, about nine or ten a-Clock in the Morning and Evening, the Obſervations which may be made on the three Points following.

1. The Height of the Mercury, divided into Inches, Lines, and Quarter-Lines, and all of the ſame Meaſure, if poſſible.

2. The

2. The Direction of the Winds, divided into eight Parts only, that is, the four principal Winds, and the four Collateral; to which one ſhould add their Forces, divided likewiſe into four Parts, except Storms and Calms.

3. The Temperature of the Air, as the Degree, Cold, and Heat, as much as may be perceiv'd by the Senſe, to make it more eaſy: To which one may alſo add the Time, for the Satisfaction of thoſe who deſire it; remembering, however, that this third Article is not abſolutely neceſſary to diſcover the Truth of the Syſtem; but is only ſet down here for thoſe who are willing entirely to ſatisfy their Curioſity.

This ſhows that theſe Obſervations may be made by all ſorts of Perſons, without any Neceſſity of having Recourſe to any Obſervator; ſince this may be done without neglecting or prejudicing any Buſineſs one may otherwiſe have, and without taking one off from other Employment, there being only an actual Reſidence in one Place neceſſary; ſo that all the Difficulty conſiſts only in making theſe Obſervations in ſuch a Manner, that every Obſervator may underſtand one another; ſo that they may have an Intercommunication of Journals and Obſervations, to be compar'd together, for the Satisfaction of thoſe who might deſire to make Remarks thereupon.

There is no Difficulty in eſtabliſhing theſe Obſervations all over *Europe*, nor to bring together the Journals of the Obſervators, in order to make them publick; there being every where

where Univerſities and Colleges, with Profeſſors and Maſters, that teach Philoſophy, who would undertake, with Pleaſure, to make theſe Obſervations; and the more willingly, becauſe it is what would be uſeful to them, and yield them Pleaſure and Satisfaction without coſting them any Thing.

In reſpect to the Publication of the Journals thus to be made, the Memoirs of the Royal Academy of Sciences, which come out every Year, would be very proper for it; wherein, if the Journals, by being too large, could not be inſerted, one might make a particular Collection, to be publiſh'd from Time to Time, as every Year, or otherwiſe, from whence thoſe who pleaſe themſelves with philoſophical Curioſities, might receive a great deal of Satisfaction; and many others would alſo have the Pleaſure of ſeeing how the Barometer has vary'd, what Wind blew, and what Weather it has been in one Day in all *Europe*, and even over all the World.

If after this one thinks it proper to extend ones Obſervations farther, one might hereby alſo ſee how the Air circulates in the World by means of the Winds; how Heat and Cold, Rain and fair Weather ſucceed each other, and paſs from one Part of the Earth to the other: And if one would farther add, at the End, the moſt remarkable Things which happen in the Air, with the Degrees of Cold and Heat on the *Thermometer*, it would be a more accompliſh'd Work; but which would entirely depend on the Curioſity of the Obſervators.

The Number of Obſervators is indifferent; but it is eaſy to comprehend, that the more there are, the greater Diſcoveries may be made, and the Reflections and Remarks more eaſy: However, in my Opinion, it would not be neceſſary to let them be nearer than fifty Leagues off each other, and then twelve at firſt might be ſufficient; afterwards one might encreaſe the Number, if it were neceſſary, and according as one might ſee convenient.

As to the Places where they might reſide, it is alſo a Matter indifferent, in ſome Reſpects; but it would be proper that they ſhould be in Places ſituated in a flat Country, and near the Sea, not near high Mountains, becauſe of the Winds, which generally vary very much in ſuch like Places, as well in relation to their Force as Direction, when they ſtrive to paſs about or over the Mountains.

It would alſo be proper, that the Obſervators begin their Journals in the Month of *April*, which is the End of the Winter; that every Year of Obſervation might contain in it thoſe of Summer and Winter entirely compleat. About the End of every Year each Obſervator would have nothing elſe to do, but to ſend his Journal to thoſe whom he made it for, who would be glad to take on them the Care of putting it in Order, and of its Publication.

It would be farther proper, for Exactneſs Sake, that every Obſervator make at the Top of his Journal at what Height, as near as poſſible, his Barometer is plac'd above the Superficies of the Water of the Sea, or that of the next River.

Here

Here follows a Method which I my ſelf made Uſe of in my Obſervations, for a great many Years together.

Example of a Journal,

At the *Hague*, 1718, the Barometer being elevated from 15 to 20 Foot.

April.	The Winds,	Their Force.	The Weather.	Temperature of the Air.	Height of the ☿. Inches.	Lines.	¼ Lines.
1	N. N. E.	C. S.	V.	H.	28	1 2	0 1
2	E. S. E.	P. 1 P. 2	R.	C.		3 4	2 3
3	S. S. W.	S. 1 S. 2	F. W.	H. 1 H. 2		5 6	0 1
4	W. N. W.	C. S.	Sn.	C. 1 C. 2		7 8	2 3
5	S. E. S. E	P. 1 P. 2	C.	T.		9 10	0 1
6	E. W.	S. 1 S. 2	C. W.			11 0	2 3
7			M.			1 2	4 0
8			H.			3 4	1 2
1.	2.	3.	4.	5.	6.	7.	8.

The Explanation.

This Journal, as we ſee, is divided into eight Columns.

1. The firſt ſhews the Days of the Month, to thirty or thirty one, according as it falls out.

2. The ſecond Column ſhews the Winds by the firſt Letter of their Names. N. ſignifies *North*, N. E. *North Eaſt*; E. *Eaſt*, S. E. *South Eaſt*; S. *South*, S. W. *South Weſt*; W. *Weſt*, N. W. *North Weſt*; and thoſe who would be more exact, may put a Point at the Top to mark it more *North*, and another at Bottom to mark it more *South:* Thus, when the Wind ſhall happen to be *Eaſt South Eaſt*, one may mark it thus, S. E. if *Eaſt North Eaſt*, thus, E. N. E. and ſo of the reſt.

3. The third Column ſhews the Force of the Winds, divided only into four. C. ſignifies *calm*; S. *ſtormy:* P. *paſſable*; P. 1. *paſſable in the firſt Degree*; P. 2. *paſſable in the ſecond Degree* of their Force: S. *ſtrong*; S. 1. *ſtrong in the firſt Degree*; S. 2. *ſtrong in the ſecond Degree.*

4. The fourth Column ſhews the Weather. V. *variable:* R. *rainy:* F. W. *fair Weather:* Sn. *Snow:* C. *cloudy:* C. W. *cloſe Weather:* M. *miſtling:* H. *Hail.*

5. The fifth Column ſhews the Degrees of Heat and Cold. H. *Heat:* C. *Cold:* T. *Temperate.*

6. The

6. The ſixth Column ſhews the Height of the Mercury by Inches.

7. The ſeventh ſhews the Lines above the Inches.

8. The eighth, the Quarter-Lines.

I do not think it neceſſary to make a leſſer Diviſion, for it would be troubleſome to mark the Height of the Mercury croſs the Glaſs more preciſely than by Quarter-Lines; obſerving always, that this Height muſt be reckon'd from the Height of the round Bubble in the Tube, which Tube muſt have, at leaſt, one Line and an Half, or two Lines of Opening, that the Variations may be more ſenſible.

If one would afterwards extend theſe Obſervations from *Europe* to the other Parts of the Globe, there would, indeed, ariſe ſome few Difficulties; but ſuch as, notwithſtanding, may be eaſily ſurmounted. As the other Parts of the World are not ſo well furniſh'd with Learning and learned Men, one muſt be oblig'd to ſend them Barometers, and inſtruct them how to make their Obſervations; and, perhaps, be oblig'd even to ſend thither ſome Obſervators expreſsly for that Purpoſe, which may be done, only by giving a few Inſtructions to ſome underſtanding Perſons, as Surgeons, Chaplains, *&c.* there being *Europeans* eſtabliſh'd in all Parts of the World.

One might eſtabliſh a Perſon of Capacity in the principal Parts in *Europe*; for Example, *London*, *Amſterdam*,

Amſterdam, *Havre-de-Grace*, *Rochelle*, *Liſbon*, *Cadiz*, or elſewhere, as may be thought convenient; who ſhould have each of them a Commiſſion and Authority in foreign Countries, that they might ſend thither Barometers, with neceſſary Inſtructions, as well for their proper Uſe, as to make Obſervations, which might eaſily be done by Means of ſome underſtanding Perſon aboard any Merchant-Ship that trades to ſuch diſtant Countries; and, by the ſame Way, they might receive, in due Time, the Journals of Obſervations, to ſend them to thoſe from whom they ſhall have Commiſſion ſo to do, in order to their making of them publick.

CHAP.

CHAP. IV.

Conſiderations upon the Form of the Globe of the Earth.

PHiloſophers are no more agree'd upon the Figure of the Globe of the Earth than the Mathematicians: The major Part, indeed, agree, that it is not perfectly round; but ſome believe of the Form of a *Sphæroid*, ſtretching itſelf towards the Poles, in ſhape like an Egg: Others, on the contrary, believe it to be flattiſh towards the Poles, ſo as to make the Circle of the Æquator much larger than the Meridians.

Mr. *Huygens* and Sir *Iſaac Newton* having found, that the Length of a Pendulum that beats the Seconds, was ſhorter under the Torrid Zone than at *Paris*, (as has been taken Notice of in the Aſtronomical Obſervations,) invented Syſtems, by which they pretend to prove this Flatneſs of the Earth; inſomuch, that the latter has found, by his Calculation, that its Superficies near the Æquator was 85200 Foot higher under the Poles; and that heavy Bodies, under the Æquator, were diminiſh'd

niſh'd $\frac{1}{131}$ Parts of the Gravity they had under the Poles.

But their having founded the Principle of their Syſtems upon the Diminution of heavy Bodies towards the Æquator, and neither all their Reaſons, nor the Diminution of the Length of the Pendulum, proving ſuch Dimunition as I have explain'd in my *Treatiſe of Phyſicks*, their Syſtems, of Conſequence, conclude nothing poſitive in relation to the Form of the Globe of the Earth.

By the Obſervations which M. *Caſſini*, and the other Members of the Royal Academy of Sciences have made in *France*, it has been found out, that the Degrees go on diminiſhing from the South towards the North $\frac{1}{100}$ Part of the Precedent: One might therefore conclude that the Globe of the Earth is longiſh towards the Poles, as is well known to thoſe who have any Knowledge of the firſt Principles of Geometry; and not flattiſh, as Monſieur *le Fontenelle*, and ſeveral other learned Men, after him have believ'd.

But, as heavy Bodies muſt diminiſh or augment their Gravity, in the ſame Proportion with that of the Degrees, as I prove in my *Treatiſe of Phyſicks*, there neceſſarily follow two Abſurdities in this Syſtem of Sir *Iſaac Newton*'s: Firſt, That the Diminution of heavy Bodies would be much greater than he has obſerv'd; and ſecondly, that the Superficies of the Sea would be lower under the Æquator, than towards the Poles; whereas, according to his Opinion, it would be higher, by 85200 Foot under the Æquator, than under the Poles.

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But, however it be, it is certain, that if we could be aſſur'd of the true Form of the Earth, we might make a great many fine Diſcoveries in *Phyſicks*, and we ſhould reaſon with more Solidity on the Nature of heavy Bodies, the Motions of the Planets, and a great many other Things, as I have explain'd in my *Treatiſe of Phyſicks*.

Now there are two Ways, by which we may come to ſuch Certainty; one whereof is the Proportion of heavy Bodies of ſeveral Species, which would change, as well as their Specifick Gravities; and the other is by Aſtronomical Obſervations, which, indeed, is the ſureſt Way.

One cannot doubt of the Obſervations which have been made in *France*, to determine the Extent of a Degree; but, as it is only M. *Caſſini*, who perceiv'd their Diminution, the Thing is of Conſequence enough to merit Confirmation by other Obſervations and other Obſervators, ſince, in Aſtronomical Obſervations, as well as Geometrical, one is oblig'd to make a great Number of Obſervations, and, very often, with faulty Inſtruments, or ſuch as are not abſolutely exact and juſt; which is the Cauſe of Miſtakes, and makes us not able to determine the Diminution of the Degrees with ſo much Juſtice as thoſe Gentlemen have obſerv'd.

Beſides *France* not being of a ſufficient Extent ſo juſtly to determine their Difference, nor, by Conſequence the true Form of the Globe of the Earth; makes me of the ſame Sentiment with M. *Caſſini*, in relation to what he ſays, *viz.* that it would be much to be deſir'd, that Chriſtian Princes, and particularly thoſe

who are interested in Navigation and Commerce, would make some Expence, in order to penetrate into Sciences, and, particularly, to establish Observators, who might be People of Experience and Probity, to determine the Diminution of the Degrees of the Earth, and to know it's true Form; by means of which one might make a great many Discoveries in *Physicks*, as I hinted above.

The Extent of *France* then being not large enough to determine by Observations, which have there been and may be made of the Extent of the Degrees of the Earth, with sufficient Exactness to know their Difference, that Difference being too little, and not sensible enough to gives us any Notion of the true Form of the Earth, one must, to effect this, send some Observators under the Torrid Zone, to take exactly the Difference of a Degree near the *Æquator*, and afterwards to send the same Observators to find out also the Extent of a Degree, the nearest as possibly can be to the Poles, which would be the true Means of knowing the Form of the Globe of the Earth.

For if this Globe is not perfectly round, as a great many modern Mathematicians have believ'd, the Extent of these Degrees cannot be equal; nor can heavy Bodies, of Consequence, have the same Gravity every where; for they would both respectively continue diminishing or encreasing, from South to North, according as the Globe of the Earth is either longish or flattish towards the Poles.

But if the Globe of the Earth be flattish towards the Poles, the Extent of the Degrees and Gravity of Bodies must continue encreasing

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from South to North; and, on the contrary, they muſt both continue diminiſhing, from South to North, if the Globe of the Earth be longiſh towards the Poles: And as their greateſt Difference is under the Poles and *Æquator*, it is in theſe Parts we ought to obſerve them, in order to their Diſcovery and our better Knowledge of them.

To comprehend the Conſequences which might be drawn from theſe Obſervations, and the Knowledge of the Form of the Globe of the Earth, we muſt conſider that the Superficies of the Globe of the Earth is terminated by the Superficies of the Waters of the Sea, which is a liquid and fluid Body. We muſt likewiſe conſider what are heavy Bodies, or, rather, the Weight of theſe Waters, which muſt counterballance each other in all Parts of the World, and which muſt likewiſe cauſe the Form of the Globe of the Earth.

We muſt moreoverobſerve,that if there be any Inequality of Gravity between the heavy Bodies in one Part of theEarth, and thoſe of another Part, one does not know how to attribute the Cauſe of this Difference, otherwiſe than to the daily Revolution of the Globe of the Earth. In ſhort, we muſt conſider that the Form of the Earth, the Extent of its Degrees, and the Gravity of Bodies, have ſuch a ſtrict Communication with each other, that one could not ſubſiſt without the other.

Now, as we prove by the Principles of Geometry, that the Degrees of the Earth, taken in different Diſtances of the Poles, are to each other in reciprocal Proportion of its Diameter to the ſame Places; and as we alſo prove by

the Rules of *Staticks*, that heavy Bodies, in different Parts of the Earth, are to each other in reciprocal Proportion of its Diameter, we conclude that the Extent of a Degree, at ſome Part of the Earth, is, to the Extent of another Degree in another Part, in the ſame Proportion as the ſpecifick Gravities of Bodies of the ſame Places are to each other, as I explain at large in my Treatiſe of *Phyſicks*: That is, the heavy Bodies under the Poles are to the heavy Bodies under the *Æquator* in the ſame Proportion of Extent of a Degree under the Poles to that of a Degree under the *Æquator*; and that the Extent of a Degree under the Poles is to the Extent of a Degree under the *Æquator*, as the Diameter of the Earth under the *Æquator* is to its Diameter under the Poles, which is its Axis.

From all which we may conclude, that if by Obſervations we find that the Extent of Degrees under the Poles, is equal to the Extent of Degrees near the *Æquator*, we might reſt aſſured that the Globe of the Earth is perfectly round; and conſequently as heavy Bodies are equal all over the Earth, we ſhall alſo know that there is only one Cauſe which can produce the Gravity of Bodies, which is the attractive Virtue of the Globe of the Earth, which Virtue, is in all its ſeparate Parts, and in every Drop of Water in particular, as is explain'd in my Treatiſe of *Phyſicks*. We ſhall moreover be aſſur'd that the daily Revolution of the Earth upon its Axis, produces no Effect on heavy Bodies, as the greateſt Number of modern Philoſophers have believ'd; and neither that the Sun produces any Effects upon the Earth or Planets, by Means

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of the ſwift Motion which whirls them about; and this is what appears moſt likely to me.

But, if on the contrary, by theſe Obſervations one finds, that the Degrees near the Poles are not equal to thoſe under the *Æquator*, one ſhall be convinc'd that there are two Cauſes which concur to the Gravity of Bodies; one of which muſt be attributed to the attractive Virtue of the Earth, as I have ſaid, and the other to the daily Revolution of the Earth about its Axis. But theſe two Cauſes produce different Effects, which are, that by the former the Earth attracts heavy Bodies towards its Centre; and by the other, on the contrary, they are puſh'd from it, or elſe attracted towards its Axis, with a Force in Proportion to their Motion. Whence it comes to paſs, that this laſt Cauſe producing a greater Effect on heavy Bodies at one Place of the Earth than at another, muſt alſo make theſe heavy Bodies of different Gravities.

I ſay, that the daily Revolution of the Earth attracts heavy Bodies towards its Axis, or puſhes them off, which is, as every one knows, a great Queſtion amongſt Philoſophers. Some having laid down one of theſe Opinions, and others again the other, as a Foundation of their Syſtems, which muſt produce Effects directly oppoſite to each other; but by Means of theſe Obſervations one might eaſily know who had the Truth of their Side, and this famous Queſtion would be decided.

For if it be found by theſe Obſervations, that the Extent of one Degree under the Poles is greater than that of a Degree under the *Æquator*, one ſhall then know, that the Globe of the Earth

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is flattiſh towards the Poles; and by the Difference of theſe two Degrees, one ſhall alſo know how much the Earth is thus flatten'd, and how much larger its Diameter under the *Æquator* is than that under the Poles.

We ſhall, moreover, know that heavy Bodies have a greater ſpecifick Gravity under the Poles than near the *Æquator*; and that the Gravity of a Body under the Poles, is to the Gravity of the ſame Body under the *Æquinoctial*, as the Extent of one Degree under the *Æquator*; and that the daily Revolution of the Globe of the Earth round its Axis, has an Effect on all heavy Bodies, which ſtrive to keep at a Diſtance from the Centre of its Revolution, which is its Axis, keeping a Direction which is perpendicular to it, as ſhall afterwards be explain'd.

But if, on the contrary, it be found by theſe Obſervations, that the Extent of a Degree under the Poles is leſs than under the *Æquator*, one ſhall then know for certain that the Globe of the Earth is of a ſpheroidical Figure, and longiſh towards the Poles; and by the Difference of theſe two Degrees, one ſhall know how much longer 'tis than broad: One ſhall moreover know, that the ſame Bodies have a greater Gravity near the *Æquator* than towards the Poles, and how much they differ; as alſo, that the daily Revolution of the Globe of the Earth enforces heavy Bodies to approach it, from the Centre of Revolution, which is the Axis of the Earth, by a Direction which is perpendicular to it, as is herein after explain'd.

If it be true, that the Degrees go on diminiſhing from South to North, as hath been obſerv'd

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in *France*, then it is most certain that the Globe of the Earth is longish towards the Poles; and that heavy Bodies in like Manner diminish from South to North. But these Observations wanting to be confirm'd before one should depend upon them, it must not be taken ill if in the mean Time I form the two Systems following, both of them on these two *Hypotheses*, in order to judge which of the two is most likely to be true.

CHAP.

CHAP. V.

System of the Diminution of heavy Bodies, according to the Hypotheses of the Flattishness of the Globe of the Earth.

TO explain the Cause of the Gravity of heavy Bodies, Philosophers are wont to make Use of the Example of a Sling; for, say they, in turning about a Sling, we may perceive that it attracts our Hand; and the faster we whirl it about, the stronger will be its Attraction, even 'till the Sling (sometimes) breaks; so that by applying this Example to the daily Revolution of the Earth round its Axis, they conclude, that it obliges all Bodies to keep at Distance from its Centre.

But these Bodies being of different Natures, some of grosser Matter, and others of more subtile, they tell us, that some of them being more susceptible of the Impression of this circular Motion than others, they have acquired also a different Swiftness in keeping themselves distant from their Revolution; and thence conclude, that those which were most susceptible of this Movement, and which acquir'd a greater

Swiftneſs in keeping themſelves diſtant from the Centre of their proper Movement, forc'd others to approach them, becauſe there being no Vacuum in Nature, they could not otherwiſe be diſtant from this Centre. And as they ſuppos'd that the moſt ſubtile Matter was moſt ſubject to this Movement, they concluded, that it muſt puſh back Bodies towards the Centre of the Earth, which is the Cauſe of the Gravity which we find in heavy Bodies.

Others having obſerv'd, that heavy Bodies, according to this Syſtem, muſt be puſh'd towards the Axis of the Earth, and not towards its Centre, have ſuppos'd, that the ſubtile Matter which encompaſſes the Earth, moves itſelf every Way; which Suppoſition is abſurd, it being not poſſible to comprehend by Reaſon, that a Thing can move itſelf every Way; for when we ſuppoſe that it moves itſelf but after one certain Manner, we cannot ſuppoſe it moves in a Manner quite contrary, without deſtroying the former Suppoſition and the former Movement.

But, as we cannot prove the Cauſe of Gravity by either of theſe two Syſtems, I rather chuſe to ſtick to this Suppoſition of the attractive Virtue of the Globe of the Earth, which attracts all heavy Bodies towards its Centre, and makes it to be perfectly round.

For, as to Suppoſition: For Suppoſition, it is certain one had better ſuppoſe the Thing to be fact, than to ſuppoſe only the Materials for the pleaſure of Forming it according to one's Fancy, where one often finds one's ſelf deceiv'd, the Thing being ill made, as has been the Caſe of a great many Philoſophers. Beſides, I am

very ſtrongly perſwaded, that we ſhall never diſcover another Cauſe than what I have here advanc'd; and that no Man will ever be able to give better Reaſons than I give.

But it is not the ſame in Relation to the Cauſe of the Flattiſhneſs of the Earth; for if it be true, that it is thus Flattiſh, one may give very natural and very probable Reaſons for its being ſo. Thoſe who have built their Syſtems upon this Foundation, taking it for a Principle of their Opinion, have had Recourſe to the ſame Example of a Stone whirl'd about in a Sling, which ſtrives to diſtance itſelf from the Centre of its Revolution; and from thence they conclude, that the daily Revolution of the Globe of the Earth about its Axis, making the ſame Effort on all heavy Bodies, as the circular Motion of the Sling does on the Stone, obliges them in the like Manner to make an Effort to remove themſelves from the Centre of their Revolution, which is the Axis of the Earth, and that by a Direction perpendicular to this Axis, in ſuch Sort, that they are only retain'd by their proper Gravity, or becauſe the Force which draws them towards the Centre of the Earth, is greater than that which drives them from its Axis, after the ſame Manner as the Stone is retain'd in the Sling, by Means of the Cord which hinders it from following its natural Inclination which it has to remove itſelf from the Centre of its Revolution; which plainly makes it appear, that there are two Cauſes which concur to the Gravity of Bodies, namely their Tendency to the Centre of the Earth, and their Inclination to remove themſelves from its Axis, in ſuch Sort, that if the former only

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ubſiſted, the Globe of the Earth would be perectly round; whereas, if the latter only ſubiſted, the World would deſtroy itſelf, becauſe ll heavy Bodies would remove themſelves from heir Revolutions.

But as the heavy Bodies, which are under the *Equator*, and, by Conſequence, which are reoteſt from the Centre of their Revolution, hich is the Axis about which the Earth turns, niſh their Revolution at the ſame Time thoſe o which are near the Poles, and by Conſeuence nearer the Axis of the Earth, which is he Centre of their circular Motion; it follows, hat they muſt alſo make a greater Effort to emove themſelves from the Axis of the Earth, nd conſequently, alſo, muſt make a greater eſiſtance to their Tendency towards the Centre f it.

Beſides, under the *Æquator*, this Reſiſtance ppoſes itſelf directly to their Tendency to the entre of the Earth; whereas, under the Poles, oppoſes it only *obliquely*; whence it is concluded, that the Force of their Reſiſtance to e Gravity of Bodies, diminiſhes doubly, in oportion of the Diminution of the *Sinus* of eir removing themſelves from the Poles; and nſequently, that heavy Bodies muſt diminiſh their Gravity in the ſame Proportion, accordg as they approach the *Æquator*; whence ollows, that the Globe of the Earth muſt be ttiſh towards the Poles, under which the ect of heavy Bodies, to remove themſelves m the Centre of their Revolution, and to poſe themſelves to their Tendency towards Centre of the Earth, is not ſenſible.

Which makes it plainly appear, that if by Obſervations we could know the Difference o the two Diameters, we ſhould at the ſame Time know the Diminution of heavy Bodies the Diameter of the Earth, and the Diſtance o the Degrees of all the Parts of the Earth, by the Proportion of the *Sinus* of their removing from the Poles, which is always in double Pro portion of the little to the great Diameter o the Earth, as is particularly explain'd in my *Treatiſe of Phyſicks.*

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CHAP. VI.

Reflections on this Syſtem.

THIS Syſtem being founded on an Example of which all the World may make an Experiment, and be convinc'd by themſelves, I do not doubt but it will be found to be very natural, and likely to be true. However, there are in it ſome Difficulties which are contrary to other Experiments.

For if heavy Bodies diminiſh their Gravity in Proportion as they approach the *Æquator*, we muſt conclude, that the Difference of the Specifick Gravities of heavy Bodies of different Kinds, muſt alſo diminiſh in the ſame Proportion; and thence it follows, that the Difference which is between the Gravity of the Air and that of the Mercury, is leſs under the *Æquator* than towards the Poles; and that it diminiſhes in going from North to South, whence is drawn this Conſequence, *viz.* that the Mercury of the Barometer muſt riſe higher under the *Æquator* than towards the Poles, which is contrary to ſeveral Experiments that have been made of it,

it, by which one finds, on the contrary, that the Mercury does not riſe ſo high under the *Æquator* as near the Poles.

Again, this Argument and theſe Experiments againſt this Syſtem, ſeem, in ſome Manner, to deſtroy it; and prove, on the contrary, that heavy Bodies muſt diminiſh in going from South to North, and, conſequently, that the Globe of the Earth muſt be longiſh towards the Poles. One may, however, refute theſe Reaſons by others which are no leſs cogent.

For if the daily Revolution of the Earth obliges all heavy Bodies to endeavour to remove themſelves from the Centre of their circular Motion, which is its Axis, it is eaſy to conceive, that all thoſe Bodies which have more Specifick Gravity, muſt likewiſe make greater Efforts to remove themſelves in ſuch Sort as the Earth making a greater Effort to remove itſelf from the Axis of the Earth than the Air, as having more Specifick Gravity: It follows, that the Superficies of the Water of the Sea, under the Torrid Zone, muſt riſe higher, in Proportion, than the Superficies of the Atmoſphere of the Air; and, conſequently, there being leſs Thickneſs between theſe two Superficies under the *Æquator*, than towards the Poles, the Barometer, in like Manner, muſt not riſe ſo high, becauſe the Air has leſs Gravity, in Proportion, as the Superficies of its Atmoſphere is leſs elevated.

Which plainly ſhews, there is very little Certainty in *Phyſical* Arguments, and that theſe two Reaſons ſeem to deſtroy each other. For, in the firſt Caſe, the Diminution of the Gravity of the Mercury exceeding the Diminution of

the

the Heighth of the Atmoſphere of the Air, muſt, of Neceſſity, cauſe the Mercury of the Barometer to riſe higher under the *Æquator* than towards the Poles; and in the other, the Diminution of the Heighth of the Atmoſphere exceeding the Diminution of the Gravity of the Mercury, it follows, that the Mercury muſt riſe not ſo high under the Torrid Zone as towards the Poles, according to thoſe Experiments which have been made of it; ſo that the whole Queſtion is reduc'd to this, *viz.* If the Diminution of the Heighth of the Atmoſphere of the Air, under the Torrid Zone, which is to the Proportion of the Gravity of the Water to that of the Air, exceeds the Diminution of the Specifick Gravity of the Mercury, which is to the Proportion of the Gravity of the Mercury to that of the Air, and conſequently greater than that of the Water; this Reaſon ſeems ſtill to deſtroy itſelf by another more weighty.

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CHAP. VII.

Syſtem of the Diminution of heavy Bodies, according to the Hypotheſis of the Globe of the Earth being longiſh towards the Poles.

IT has been already ſaid, in this Syſtem, as well as in the former, that there muſt two Cauſes concur to the Gravity of Bodies, *viz.* The natural Attraction of the Globe of the Earth; and an other, which one muſt attribute to the daily Revolution of the Globe of the Earth. Which muſt produce contrary Effects and directly oppoſite to the foregoing Syſtem.

For, whereas, in the foregoing Syſtem, we ſuppos'd that heavy Bodies, being compos'd of groſſer Matter, are more ſubject to the circular Revolution of the Earth about its Axis, and conſequently make greater Efforts to remove themſelves from the Centre of their Motion, which is the Axis of the Earth; in this Syſtem, on the contrary, one muſt ſuppoſe that it is Matter the moſt ſubtile, which is the moſt ſuſceptible

ſuſceptible of the circular Motion of the Whirling that is produc'd by the daily Revolution of the Earth about its Axis; and, by conſequence, that this ſubtile Matter makes a greater Effort to remove itſelf from the Centre of the Earth.

But all being full in Nature, this Effort of the ſubtile Matter obliges heavy Bodies to ſettle themſelves, in puſhing them back towards the Centre of their Revolution, by a Direction which is perpendicular to the Axis of the Earth, in the ſame Manner as *Des Cartes* and other Philoſophers have explain'd the Cauſe of Gravity.

But be this as it will, it is certain, that if the Earth is longiſh towards the Poles, the Cauſe of it muſt be attributed to a like Preſſure of the ſubtile Matter, which preſſes it more towards the *Æquator*, and forces the Waters of the Sea to retire towards the Poles, where this Preſſure is leſs ſenſible; in ſuch Manner, that this Preſſure, which is perpendicular to the Axis of the Earth, meeting the Superficies of the Globe of the Earth perpendicularly under the Torrid Zone, and obliquely, more and more in Proportion as it approaches more towards the Poles, it follows, that it muſt make a greater Effort to puſh back heavy Bodies towards the Centre of the Earth, under the Torrid Zone, than towards the Poles.

For, tho' this Preſſure, perpendicular to the Axis of the Earth, be every Way equal, as it ſeems it muſt be in one Senſe, it does not, however, produce the ſame Effect on heavy Bodies in all Parts of the Earth; becauſe it meets their Direction, where their Tendency to the Centre of the Earth is more and more,

oblique, in Proportion as they approach more towards the Poles, in ſuch Manner, that this Preſſure, under the Torrid Zone, moves, with all its Force, with the Tendency of heavy Bodies, to the Centre of the Earth, and augments, by Conſequence, the Specifick Gravity of all this Force; whereas it diminiſhes this Force and this Gravity, in obliquely meeting heavy Bodies approaching the Poles, in Proportion of the *Sinus* of their Diſtance from the Poles. It muſt, moreover, be believ'd, in another Senſe, that the ſubtile Matter diminiſhes the Force of its Preſſure, in Proportion as it is nearer the Poles; becauſe it has leſs circular Motion, in Proportion as it approaches nearer the Centre of its Revolution, as is eaſy to comprehend by the Roundneſs of the Globe of the Earth.

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CHAP. VIII.

Reflections on this Syſtem.

ONE cannot deny, but that this Syſtem is wrought up with greater Art and Care than the former, which may make it look, in the Opinion of ſome People, leſs natural and probable. Beſides, that it contains ſome Difficulties, which, at firſt Sight, may appear ſo contrary to the *Hypotheſis*, that, if one do not examine 'em throughly in all their Circumſtances, one muſt abſolutely reject it. But after having well examin'd the Whole, one ſhall find nothing in it contrary to thoſe Experiments we make every Day.

One of the principal Difficulties which may be objected againſt this Syſtem, is, that if one ſuppoſes, for Example, that the Globe of the Earth is longiſh 85,200 Foot, (*i. e.* if the Superficies of the Waters of the Sea, which determines that of the Globe of the Earth, be 85,200 Foot higher under the Poles than under the *Æquator*; which is the ſame Quantity as (according to the Calculation of Sir *Iſaac*

Newton, who ſuppoſes the Flatneſs of the Globe of the Earth) is higher under the *Æquator* than under the Poles) it would follow, that the Force of the Preſſure, which is the Cauſe of this Length, and which we muſt attribute to the ſubtile Matter, muſt be, under the *Æquator*, equal to the perpendicular Gravity of 85,200 Foot of Water, ſince it is this Preſſure which forces back the Waters of the Sea towards the Poles, and which retains them in an equal Poize to this Elevation, by hindering them from flowing back towards the *Æquator*, to make them level, and to make the Globe of the Earth perfectly round. And from thence we conclude, that this ſame Preſſure, which, according to all Appearances, muſt produce the ſame Effect, and preſs with the ſame Force the Superficies of the Mercury which is in the Box of the Barometer, as the Superficies of the Water of the Sea, muſt make the Mercury riſe in the Tube more than 6000 Foot higher near the *Æquator* than under the Poles, which is abſurd.

Another Difficulty which preſents itſelf againſt this Syſtem, is, That this Preſſure of the ſubtile Matter, which would, according to our former Suppoſition, be equal to the Gravity of 85,200 Foot of Water, would then be ſtronger than the Preſſure of the *Atmoſphere* of the Air; and as the whole *Atmoſphere* of the Air finds it ſelf ſhut up between the ſubtile Matter and the Superficies of the Water of the Sea it ſeems probable, that this Preſſure, before it communicates itſelf to the Waters of the Sea muſt in like manner compreſs the whole Atmoſphere of the Air which is between them

both

both under the Torrid Zone, ſo as to make it unable longer to ſtay there, or a very little of it upon the Earth; and which muſt entirely be driven back towards the Poles by this Preſſure, ſince it would be then capable to retire thither, and ſuſtain 85,200 Foot of Water, which would be a ſecond Abſurdity no leſs conſiderable than the other.

However, it is not impoſſible to ſolve this Difficulty, by Reaſons not only probable but alſo very natural, by ſuppoſing only one Thing, which it ſeems ought otherwiſe to be abſolutely ſuppoſed. If one conſiders the Qualities of the ſubtile Matter, as alſo thoſe of the Air, Sea, Glaſs, and other tranſparent Matters, one ſhall find that there muſt neceſſarily be a great Quantity of ſubtile Matter mix'd with the Air, in ſuch ſort, that by its Means that which is above the Atmoſphere of the Air freely penetrates it, to communicate its Preſſure to the Superficies of the Sea, without cauſing upon it any more than the leaſt Force, or none at all, to compreſs it. So that by means of this Suppoſition, which will appear yet moſt neceſſary by and by, to explain the Effects of the Flux and Reflux of the Sea, the ſecond Difficulty is removed; and one ſhall eaſily comprehend, that this Preſſure of the ſubtile Matter may communicate itſelf to the Superficies of the Sea, without compreſſing, either very little, or not at all, the Atmoſphere of the Air, which is between them.

The firſt Difficulty appears yet more eaſy to be remov'd, ſince after all the Reaſons and Experiments the learn'd *Huygeus* has given us in his excellent *Treatiſe of Light*, one cannot doubt

doubt but the ſubtile Matter goes through the Glaſs in the ſame manner as all tranſparent Bodies, and, perhaps, more than the Air it ſelf. To which one may moreover add, that by thoſe common Experiments we every Day make, we find that Light communicates it ſelf from one Place to another, by means of the ſubtile Matter, without any Aſſiſtance of Air. A Chamber, for Example, would no more be enlightned through the Glaſs in the Windows, than through a Door, if the ſubtile Matter did not paſs through the Glaſs, to communicate the Light to the Room, with ſuch Liberty, as if it had no Body to oppoſe it: For we know that the Thickneſs of the Glaſs of the Window, ſeparates the Air of the Room from that without, and hinders the outward Air from communicating its Light to that within.

This being ſuppos'd, it is eaſy to conceive, that the ſubtile Matter paſſing through the Glaſs of the Tube of the Barometer with as much Liberty as the Air itſelf, its extraordinary Preſſure under the Torrid Zone muſt have the ſame Effects on the Superficies of the Mercury which is in the Tube, as upon that which is in the Box, in ſuch Sort, that theſe two Efforts counterbalancing each other, cannot produce any Effect on the Barometer, or cauſe any Alteration in its ordinary Heighth, or its Variation; and it is alſo for the ſame Reaſon, that the Preſſure of the Moon, to which we attribute the Cauſe of the Flux and Reflux of the Sea, is not ſenſible in the Barometer, becauſe this Preſſure is every where equal.

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However, it ſeems all the Learned are not agreed that the ſubtile Matter can paſs through Glaſs: Monſieur *Dortous* asks this Queſtion, *What can this Matter be, which can paſs freely through the Pores of the Glaſs of the Barometer, and yet find ſuch Reſiſtance in the Water?*

But he ſhould have conſider'd, that in *Phyſicks* there a great many Things, which Experience tells us, ſubſiſt in Nature, though we cannot give any poſitive Reaſon why; and I cannot ſee any Reaſon why Monſieur *Dortous* ſhould ask this Queſtion, than this; *viz.* Why Wood, Copper, Iron, or other Matters, are not tranſparent as Glaſs and Chryſtal; for tho' one cannot give any poſitive Reaſon for this, it does not therefore follow, that Glaſs and Chryſtal are not tranſparent.

In like manner, tho' we cannot know how ſubtile Matter penetrates Glaſs, and finds Reſiſtance in Water, it does not therefore follow that it does not penetrate Glaſs; and one has no more reaſon to deny this Penetration, than to deny the Tranſparency of Glaſs; or that, at leaſt, one is ſenſible to us, and the other not; which is no good Reaſon at all.

It muſt likewiſe be conſider'd, that we are not certain that the Preſſure of the ſubtile Matter ſtops at meeting the Superficies of the Water, without paſſing through, as it does, other tranſparent Bodies. For, if the Tranſparency of Bodies is one Proof that the ſubtile Matter penetrates them, it muſt alſo penetrate Water, which is alſo tranſparent; and, by conſequence, this Preſſure of the Matter cannot be there ſenſible, or produce any Effect conſiderable enough to drive back ſo much Water towards the Poles,

Poles, as wou'd be neceſſary to form this Longiſhneſs of the Globe.

It muſt farther be conſider'd, that we are not certain that the ſubtile Matter paſſes through all tranſparent Bodies with the ſame Facility, nor that it paſſes through opaque Bodies in the ſame manner as tranſparent. But if we ſuppoſe, as it ſeems likely to be, that the ſubtile Matter paſſes through all tranſparent Bodies with more or leſs Facility, according as theſe Bodies are more or leſs tranſparent, then we need not take much Pains to prove the Globe of the Earth to be made longiſh, by the Preſſure of the ſubtile Matter on the Water of the Sea, though it paſſes through it; becauſe the Water being leſs tranſparent than the Air, and much leſs than Glaſs or Chryſtal, it follows, by the Suppoſition, that the ſubtile Matter will find more Reſiſtance in paſſing through the Water than the Air; and thence we conclude, that all its Preſſure, under the Torrid Zone, muſt act with all its Force againſt the Water of the Sea, which muſt ſtop it by little and little, in proportion as the Rays of Preſſure diminiſh and loſe themſelves in the Depth of Penetration. So that if one ſuppoſes the Reſiſtance of the Water to the Paſſage of the Rays of the Preſſure of the ſubtile Matter, which compreſſes the Earth under the Torrid Zone, to be 2, 6, 10, or 20 Times greater than that of the Air, one ſhall find Preſſure enough on the Waters of the Sea, to drive back one Part towards the Poles, and there produce this Lengthning out of the Globe of the Earth. This deep Penetration of the ſubtile Matter in the Waters of the Sea, is farther prov'd by the Flu-

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and Reflux of the Sea, as I explain in my Treatiſe of *Phyſicks*; of which I have added here a ſmall Extract, which has ſome Relation to the Opinion of the Earth's being flat.

After having explain'd the Reaſons which may be alledg'd for and againſt theſe two Syſtems, I believe one may, without any Prejudice, determine one ſelf in Favour of one of them, rather than the other, and by that one ſhall ſee that we cannot in this Matter come to any clear Knowledge, otherwiſe than by Aſtronomical Obſervations, to determine the juſt Extent of Degrees, and their Difference, after a manner as I have above explain'd; which would be a ſolid Foundation to form juſt Reaſons on, in relation to all Things advanc'd in theſe two Syſtems, and to diſcover at the ſame Time, all that is therein curious relating to *Phyſicks*; whereas at preſent, we reaſon upon deceitful (and very often falſe) Conjectures.

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CHAP. IX.

Reflections upon the Cauſe of the Flux and Reflux of the Sea.

ONE of the ſtrongeſt Reaſons that can be alledg'd to prove that the ſubtile Matter paſſes through Glaſs, and at the ſame Time the whole Atmoſphere of the Air without cauſing any Compreſſion, or very little or no Alteration, is the Preſſure which the Moon makes againſt the Earth, and the Superficies of the Sea, in its Paſſage through the Meridians under the Torrid Zone; and to which we attribute the Cauſe of the Flux and Reflux of the Sea; as *Deſcartes* and ſeveral other Philoſophers have explain'd.

For if one ſuppoſes, that this Preſſure upon the Superficies of the Waters of the Sea is equal to two Foot of Water, anſwering to twenty one Lines of Mercury, which Pilots aſſure us is the greateſt Difference of the Height of the Flux and Reflux of the Sea in the Iſles under the Torrid Zone; and if the ſubtile Matter, by means of which the Preſſure of the Moon is communicated to the Earth, does not paſs through

hro' the Glaſs of the Tube of the Barometer, it would follow, that this Preſſure of the Moon would be perceiv'd upon the Superficies of the Mercury in the Box of a Barometer, with the ame Force as upon the Superficies of the Water f the Sea; and, by Conſequence, that every ime the Moon ſhould paſs thro' the Meridians nder the Torrid Zone, ſhe would make the Mercury riſe 21 Lines; which is abſurd. The Matter, then, which produces this Preſſure, aſſes thro' the Glaſs, and produces the ſame ffect on the Mercury of the Tube, to counter-allance this Preſſure.

I know very well, one may explain this *Phe-omenon* after another Manner; which is, by uppoſing that the Preſſure of the Moon com-unicates itſelf to the Superficies of the Water f the Sea, by means of the Atmoſphere of he Air, which is between the Superficies of the lobe of the Earth and the ſubtile Matter, s it ſeems Monſieur *Dortous* has ſuppoſed: ut I do not find this Syſtem the more probable r being more ſimple and natural; for this reſſure of the Moon acting in that Caſe upon he Superficies of the Atmoſphere of the Air, the ſame Manner and with the ſame Force the Air would act upon the Superficies of he Water of the Sea, would likewiſe produce e ſame Effects; that is, this Preſſure of the oon would produce in the Air a Flux and eflux, which would have ſome Reſemblance that which we ſee in the Sea; for the ſubtile atter, in preſſing the Atmoſphere of the Air, nder the *Æquator*, when the Moon paſſes thro' e Meridians, would then force as much Air

below her as the Force of ſuch Preſſure could ſuſtain. As for Example: A Boat that is heavy laden, preſſing with all its Weight, upon the Superficies of the Water, diſplaces a Quantity equal to its own Weight; in like Manner, the Air, preſſed by the Paſſage of the Moon, being conſtrain'd to give Way of all Sides, one Part muſt retire on both Sides, and another retire towards the Poles, while another Part would be puſh'd on before the Moon, in the ſame Manner as a Boat that is laden forces one Part of the Water, which it diſplaces, to retire of each Side, while it puſhes another Part of before it, as may eaſily be obſerv'd by any Boat upon the Water.

This would produce upon the Earth ſeveral Effects which we do not perceive. Firſt, the Paſſage of the Moon, under the Torrid Zone would produce, in the temperate Zones, a Flux and Reflux of the Air, from the *Æquator* towards the Poles, and from the Poles towards the *Æquator*, which would have the ſame Regularity with the Flux and Reflux of the Sea. And beſides, this Flux and Reflux of the Air encreaſing and diminiſhing ſucceſſively the Mass of the Air, in the ſame Zones, would force the Barometer to riſe every Time the Moon ſhould paſs thro' the Meridians, becauſe of the Air which ſhe would puſh off; and make it fall a little after ſuch Paſſage, and the Air would retire, which we do not perceive.

Beſides, towards 25 or 30 Degrees of Northern Latitude, we ſhould find, twice a-Day two or three Hours before the Moon comes to the Meridian, South-Weſt Winds, which would

turn

turn to Weſt, when the Moon ſhould have reach'd the Meridian, and to North-Weſt after ſhe ſhould have paſs'd the Meridian.

Again, under the *Æquator*, one ſhould have twice a Day Eaſt Winds two or three Hours before the Moon comes to the Meridian; which Winds would be follow'd by a Calm of ſome ſmall Continuance; and after that, by Weſt Winds, which would grow very violent at the Inſtant the Moon paſſes the Meridian; and after ſhe has paſs'd, theſe Winds would relent by little and little, in Proportion to her Diſtance, in ſuch Manner, as to be reduc'd into a Calm, or ſome Whirl-Wind, an Hour or two after ſhe has paſs'd through.

But as one perceives nothing which has the leaſt Appearance of all this, one may poſitively conclude, that the Moon communicates her Preſſure to the Globe of the Earth and the Water of the Sea, immediately, by means of the ſubtile Matter; and that this Matter paſſes through the whole Atmoſphere of the Air, without giving it any ſenſible Impreſſion. And from thence one may draw this farther Conſequence, that the Globe of the Earth may be of longiſh Figure towards the Poles, by the Preſſure of the ſubtile Matter, without the Atmoſphere of the Air's being compreſſed, or at leaſt but very little, as I explain in my Treatiſe of *Phyſicks*.

It remains now, that we only make this one Reflection, *viz.* that if the Moon does not communicate her Preſſure to the Superficies of the Waters of the Sea but by the means of the Air, which is between her and the ſubtile Matter,

Matter, ſhe could not produce any Motion any Ways reſembling the Flux and Reflux which we there ſee; becauſe the Preſſure of the Moon againſt the Atmoſphere of the Air, in the Time ſhe paſſes thro' the Meridians under the Torrid Zone, would then ſupply the Place of the Gravity of the Air which it diſplac'd; ſo that neither the Superficies of the Sea, nor that of the Mercury of the Barometer, (being neither more nor leſs preſs'd thereby) could produce any Variation of the Barometer, or any Flux and Reflux of the Sea; juſt, as for Example, the Gravity of a Boat being in the Place of the Gravity of the Waters, whoſe Place it ſupplies, does the more burden the Banks of a River or Canal, or produce any Impreſſion in its Paſſage, unleſs it be ſome Movements, which are not ſenſible, but in Canals where the Waters are pretty much ſtraiten'd and confin'd.

By this Reaſon, we may farther prove, that the Preſſure of the ſubtile Matter does not terminate on the Superficies of the Waters of the Sea, as one might probably imagine; but, on the contrary, it viſibly appears, that the ſubtile Matter muſt penetrate the Waters of the Sea, as well as other tranſparent Bodies, tho' with leſs Facility, as has been hinted before; ſo that by this Penetration, the Preſſure of the Moon produces her Effects even in the very Bowels of the Globe of the Earth. For, as it has been obſerv'd, along the Coaſts of the Sea, and the Mouths of great Rivers, that the Flux and Reflux of the Sea does not run in or out, at moſt, more than three Leagues an Hour, we muſt conclude from thence, that if the

Preſſure

Preſſure of the Moon is only perceptible under the Torrid Zone, a Tide could not come to us under leſs than thirteen or fourteen Hours Time; and that by Conſequence, the high Tides of Conjunctions and Oppoſitions would not be at the ſame Time all over the Earth as they are.

Whereas, to prove this *Phenomenon* of Tides, which we find are at the ſame Time all the World over, one muſt of neceſſity ſuppoſe, that the Preſſure of the Moon, which produces them, extends itſelf very deep into the Waters of the Sea, that it might produce every where the ſame Effect, in the ſame Manner: As for Example, an Arrow which falls into the Water, impreſſes in it all the Force of its Motion when it is ſtopp'd; now, the Force of this Movement of the Arrow, does not communicate itſelf only to the Superficies of the Water, but ſucceſſively to all the Parts of the Water which it touches, in entering as deep as it can. We muſt conceive the ſame Penetration of the ſubtile Matter, and its Preſſure againſt and within the Waters of the Sea, with this Difference, that the ſubtile Matter penetrates farther in the Water than the Arrow.

In the ſame Manner alſo ought we to conceive its Penetration thro' the Air, and the Effects it there produces in its Paſſages. But this is philoſophiſing enough on a Matter of which we have only apparent Conjectures for Proofs; and we muſt conclude, after having well conſider'd every Thing that has been ſaid, that we underſtand nothing of it; that we ſee in the World a great many wonderful Things,

for

for which we know not how to account or give any Reaſon for.

Of this I have given a very remarkable Example in my Treatiſe of *Phyſicks*, where I make it plainly appear, that Experiments have prov'd, that hot Air is lighter than cold; that, in like Manner, it has been prov'd by Demonſtrations in Geometry the moſt evident, that this hot and light Air ought to riſe always above the cold, which is in effect more heavy, as all modern Philoſophers will ſtill have it. However, as the Earth has Occaſion of Heat, to make it fruitful and capable to produce what is neceſſary for the Support of Mankind and all Animals, which would periſh if the hot Air did riſe above the Cold: Providence has given it its Bounds, which makes it manifeſtly appear, (notwithſtanding the Opinion of all Philoſophers, and in Spite of the Demonſtrations of the Geometricians, which we hold the ſureſt and moſt infallible of Nature) and we ſee, with Admiration, that this heated Air does not riſe above the Cold; and that the Cold which is above, though more heavy, cannot deſcend into that which is heated and more light, but by forcing this Barriere, to enter it with Violence and great Claps of Thunder.

After this, I believe we can produce nothing more wonderful in Nature and more convincing of our Ignorance in *Phyſicks*; but on the other Hand, I believe, that the Study of theſe Sciences, and the Diving into the Nature of Matter, is a true Means to take from us all our Prejudices, which are contrary to the Progreſs we might make therein; for the true Means to know

know Things well, is to know that we do not yet know them; it being much more advantagious to be assur'd that we do not know a Thing, than to believe one knows it when one is ignorant of its Principles.

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CHAP. X.

Of the Variation of Tides, according to the New Syſtem.

TO know the Cauſe of the conſiderable Variations which we obſerve every Day in the Flux and Reflux of the Sea, we muſt conſider all the Cauſes that concur to their Production, and their different Combinations, with the Effects which every one of them produces in particular.

Among the different Cauſes of the Variation of the Flux and Reflux of the Sea, which I particularly explain in my Treatiſe of *Phyſicks*, I find twelve conſiderable ones, *viz.* One which depends on the Sea itſelf, one that depends on the Diſpoſition of the Coaſts, two which we muſt attribute to the Effects of the Air, two others to the Sun, five to the Moon, and another to the Planets, which is very variable, as coming from their different Conjunctions and Oppoſitions.

All

All theſe produce on the Tides different Effects, according as they are differently combin'd. But as they may be combin'd in an infinity of different Manners, one may conclude, that the Effects we obſerve therein muſt alſo be ſo different that we cannot remark them but with a great deal of Trouble in our Obſervations, excepting the principal, which we muſt attribute to the Moon and Sun, and more particularly to the Rolling of the Air or Winds which rule upon the Earth.

In Relation to the firſt Cauſe, which depends on the Sea itſelf, it muſt be conſider'd, that the Sea is not always of the ſame Height, nor equally ſmooth, but that it is always higher in Winter than in Summer, and higher yet, in rainy Weather than in a Drought: Becauſe in Winter (and the ſame may be ſaid of rainy Weather) there falls into the Sea not only more Water than can evaporate, but the Rivers that diſcharge themſelves into it bring along with them a greater Quantity than at other Times; ſo that this Quantity of Water, as well Rain as Rivers, muſt make the Sea riſe towards its Shores, before it can be puſh'd on to other Parts of the Earth. And as the contrary happens in Summer, or in Time of Drought, one muſt conclude, that the Tides muſt be ſome Feet higher; and deſcend ſo much more leſs in Winter, or in rainy Weather, than in Summer, or in Time of Drought; and that this Difference muſt be more or leſs, according as there are more or fewer Rivers to diſcharge themſelves into the Sea in one Place than in another, and alſo according as the Sea is more or leſs deep, as is eaſy to comprehend.

In relation to the Cauſe of the Diſpoſition of the Sea-Coaſts, all Mariners and others, who have Experience in the Flux and Reflux of the Sea, know very well, and *Phyſical* Reaſons prove, that the Tides are more ſenſible at the Bottom of Bays, than near Capes or Streights; and that they are in like Manner more ſenſible in thoſe Places where the Sea has but a little Depth near the Coaſts, than in ſteep Places, and where it is very deep; and again, that they are alſo more ſenſible in the Bottom of Gulphs, which have large Openings into the Sea, than in thoſe which have more ſtrait and narrow; and the Difference which ariſes from thoſe ſeveral Diſpoſitions, is very conſiderable.

The two Cauſes of the Variation of Tides, which we muſt attribute to the Air, are, firſt, the Winds, which are the moſt conſiderable; and, ſecondly, the different Gravities of the Air, which we obſerve by the Variation of the Barometer. In relation to the firſt, all thoſe who have ſome Experience in Navigation, as likewiſe all thoſe who live on the Sea Coaſts or near great Lakes, know very well, and *Phyſical* Reaſons alſo prove, that the Winds puſh the Waters of the Sea, and make them roll ſometimes on one Coaſt and ſometimes on another; ſometimes with more, ſometimes with leſs Force, according to the Coaſt and the Strength of the Winds. And from thence it follows, that when the Wind puſhes the Water from the Coaſts towards the full Sea, the Tides muſt be ſmall and the Reflux very great; whereas, when the Wind puſhes the Water againſt the Coaſts, the Tides muſt be conſi-

conſiderably greater, and the Reflux leſs: And this Difference is the more conſiderable, the more violent the Winds are; of which one very often finds ſad Experience in maritime Countries, where they ſometimes cauſe dreadful Deluges.

For the ſecond Cauſe of the Variation of the Tides, which muſt be attributed to the Air, it is eaſy to comprehend, that its Gravity producing the ſame Effect upon the Superficies of the Sea, as upon the Superficies of the Mercury of a Barometer, it muſt alſo produce on the Waters of the Sea very near the ſame Effect as on the Barometer. For as one knows by the Variation of the Barometer, that the Gravity of the Air is not equal all the Earth over, but that it is leſs or greater in one Part than in another, it is eaſy to comprehend, that this ſame Gravity of the Air muſt puſh the Waters of the Sea from the Side where they are more preſs'd by this Gravity, towards the Places where they are leſs; which happens alſo ſucceſſively in the ſame Place, when the Air comes to change, becoming more heavy or more light; whence we may conclude, that the Tides muſt be leſs high and the Reflux lower, when the Air is heavy and the Barometer high, than when the Air is higher and the Barometer lower.

Among the Cauſes which depend on the Planets, tho' the principal muſt be attributed to the Moon, I believe, however, we ſhould begin by explaining thoſe which we muſt attribute to the Sun, without being oblig'd to tell the Reaſon. But, before entering into this Detail, we ſhould take Notice, that amongſt the

the twelve Cauſes which produce the Variation of Tides, of which I have ſpoken, we muſt attribute the principal to the Moon, to accommodate ourſelves to the Opinion of Philoſophers; tho' there is great Reaſon to attribute it to the Sun, which ſeems moſt to contribute thereto, ſince this Cauſe comes from the Form of the little Vortex of the Earth, which is made Oval by the Difference of the Movement of the Vortex of the Sun; ſo that the Cauſe which produces the Ovality of the Vortex of the Earth, which muſt make it ſenſible of conſequence, even to the Superficies of the Waters of the Sea, muſt produce a Flux and Reflux, which have Periods regulated according to the Courſe of the Sun; whence one may conclude, that if there were no Moon, the Sea would have a Flux and Reflux, tho' leſs ſenſible than what we ſee, which would produce in theſe Countries high Tides every Day at twelve a-Clock, and low ones at Six; and under the Torrid Zone, high Tides at ſix a-Clock, and low ones at Twelve, when the Sun paſſes thro' the Meridians, as I have explain'd four Years ago in my Treatiſe of *Phyſicks*, and as Monſieur *Caſſini* has ſince well remark'd in his Obſervations.

This being well underſtood, it is eaſy to comprehend in its proper Place, that the Cauſe which produces this Ovality of the Vortex of the Earth, where, if I may be permitted to explain myſelf otherwiſe, the Flux of the Sun muſt be encreas'd, or diminiſh'd, in Proportion as that Planet finds itſelf more or leſs nearer to the Earth; whence one may conclude, that all Things remaining otherwiſe equal, the

Tides

Tides muſt be greater when the Sun is in its *Perigæum*, and leſs when it is in its *Apogæum*. And tho' the Difference be not very conſiderable, yet, I believe, one might perceive it alſo by the Way of Obſervation.

As to the ſecond Cauſe, which one muſt attribute to the Sun, (tho', in Effect, it depends on the Globe of the Earth as well as the foregoing,) we muſt conſider, that when the Globe of the Earth is fartheſt from the Sun, or in its *Aphelion*, its oval Vortex muſt then be more preſs'd on that Side which is oppoſite to the Sun, than that which is turn'd towards the Sun; becauſe, in that Place, the Vortex of the Earth muſt meet the Matter of the Great Vortex in a ſlower Movement, which muſt puſh it back towards the Sun by its Movement of Vibration or Irregularity, in ſuch Manner, that this unequal Preſſure, which muſt make it ſenſible even on the Superficies of the Water of the Sea, muſt alſo produce an unequal Flux and Reflux, and the Night-Tides greater than thoſe of the Day. Whereas, when the Sun is at its *Perigæum*, the Vortex of the Globe of the Earth, which is then in its *Perihelion*, neareſt the Sun, meeting there the Matter of the Great Vortex in a more rapid Movement, which ſtops, by little and little, its Movement towards the Sun, muſt, in ſhort, puſh it back with the Earth, towards the Place whence it came: It is alſo eaſy to comprehend, that this Vortex muſt then be more compacted on the Side of the Sun than on its oppoſite Side; ſo that this Preſſure making itſelf ſenſible even to the Superficies of the Waters of the Sea, muſt ſtill produce unequal Tides, thoſe of the Day being more

more ſenſible than thoſe of the Night. And tho' this Difference is not very great, yet, I am, notwithſtanding, fully perſwaded, by Obſervations, and ſo much the more, that this Cauſe, as well as the preceding, muſt produce their Effects in the Time of *Zyzygies*; and produce others oppoſite in the Time of *Quadrature*.

In relation to the Cauſes of the Variation of the Tides, which one muſt attribute to the Moon, it has been already ſaid, we muſt diſtinguiſh five; the principal of which proceeds from the Diſtance of the Moon in its *Zyzygies*, in ſuch Manner, that the nearer ſhe is, the higher are the Tides; amongſt which, thoſe which happen in the new or full Moons, are always the greateſt; and, of Conſequence thoſe which approach nearer, and the leſſer, are thoſe which happen in the Time of the *Quadratures*, when they do not come ſo near.

This Cauſe of the Variation of the Tides is attributed indirectly to the Moon, becauſe it is, in Effect, nothing elſe than a Concourſe or ſucceſſive Oppoſition of the two principal Cauſes of the Flux and Reflux of the Sea; one of which is attributed to the Moon, and the other to the Sun; but as that which we attribute to the Moon is the ſtrongeſt, it follows, that the Flux and Reflux muſt always attend the Movement of the Moon, without our perceiving that of the Sun, but only by the Variation of the Tides, which conſiderably encreaſe, and more and more, according as the Effects of the Sun concur more and more with thoſe of the Moon, as it happens in the Times of their Conjunctions or Oppoſitions, or when

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ſhe approaches the Sun; whereas, when the Moon is in *Quadrature*, theſe two Cauſes finding themſelves oppoſite to each other, becauſe the Moon then preſſes the Earth on two Sides, and the Sun on the other two, it follows, that the Effects muſt then deſtroy each other; ſo that if theſe two Compreſſions were equal, they would not produce, at that Time, any ſenſible Effect, nor any Flux and Reflux in the Sea; or, rather, would produce four Fluxes and Refluxes a Day, as it is eaſy to comprehend; but the Compreſſion of the Moon being ſtronger than that of the Sun, it produces always the ſame Effect; and that of the Sun ſerves only to encreaſe or diminiſh it, according as ſhe is either in Conjunction, Oppoſition, or Quartile.

The ſecond Cauſe of the Variation of the Tides, which depends on the Moon, muſt be attributed to her Proximity or Diſtance from the Earth. For, as the Effects which produce the Flux and Reflux of the Sea, muſt encreaſe or diminiſh, according as the Cauſe which produces them are greater or leſſer, and this Cauſe encreaſing or diminiſhing according as the Moon is more or leſs near the Earth, as I have explain'd more at large in my Treatiſe of *Phyſicks*, and as I have ſeen ſince, that Monſ. *Caſſini* has alſo remark'd in his Obſervations, it follows, That all Things remaining otherwiſe equal, the greateſt Tides muſt happen in the Time when the Moon is in her *Perigæum*, and the leſs, when ſhe is in her *Apogæum*. But this Difference is much leſs ſenſible than the foregoing, as is eaſy to comprehend.

The third Cauſe muſt be attributed to the Diſtance or the Nearneſs of the Moon to the *Æquinoctial*; becauſe, as the Compreſſion of the Moon againſt the Earth, makes a greater or leſſer Effort, in Proportion as ſhe meets it more or leſs directly; and, as ſhe meets it more obliquely, in Proportion, as ſhe is more diſtant from the *Æquator*, it follows, that all Things remaining otherwiſe equal, the greateſt Tides muſt be at the Time when the Moon paſſes thro' the *Æquinoctial*, and the leſſer when ſhe is diſtant from it, and towards the *Tropicks*.

Again, it is for the ſame Reaſon that the Compreſſion of the Moon makes a greater or leſſer Effort againſt the Earth, in Proportion as ſhe finds herſelf more or leſs near the *Ecliptick*: Whence we may alſo draw this Conſequence, that all Things remaining, otherwiſe equal, the greateſt Tides muſt be when the Moon paſſes thro' one or the other of theſe Knots, or when ſhe is eclipſed, or eclipſes the Sun, and the leaſt, in the Time of her greateſt Declination, or when ſhe is in her greateſt Diſtance from the *Ecliptick*.

To comprehend, laſtly, the fifth Cauſe of the Variation of the Tides, we muſt conſider that the Moon, by her Movement of Vibration, which others call her irregular Movement, and which is only during the Time ſhe makes her Revolution round the Earth, approaches and removes from it ſucceſſively. And as this Movement is peculiar to her, it is eaſy to comprehend, that while ſhe makes this Movement, ſhe muſt puſh before her the ſubtile Matter, in which Philoſophers have ſuppos'd ſhe floats at Liberty. But as ſhe muſt

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ouſh this ſubtile Matter towards the Earth, when ſhe approaches it, and muſt produce an ppoſite Effect when ſhe removes from it, it ollows, that the Tides muſt be more ſenſible hen ſhe paſſes from her *Apogæum* towards her *Perigæum*, than when ſhe goes from her *Perigæum* towards her *Apogæum*; but the Difference annot be very great.

As to the Cauſe of the Variation of the ides, which muſt be attributed to the Planets, ho' this is the leaſt ſenſible of them all) one uſt not, however, doubt but that when ey approach the Earth, they muſt make ainſt it an Effort reſembling that which we tribute to the Moon, which produces the lux and Reflux of the Sea, but much leſs nſible, becauſe of their great Diſtance. But is does not hinder one from concluding, that hen any inferior Planet, and particularly *nus*, paſſes between the Earth and the Sun, muſt then encreaſe the Effort which the Sun akes on the Earth, and encreaſe the Cauſes hich this Planet produces, in Reſpect of the ariation of the Tides; ſo that all Things beg otherwiſe equal, the Tides of the *Zygygies* ſt encreaſe, and thoſe of the Quadratures miniſh, by the Junction of *Mercury*, and more rticularly *Venus*, with the Sun. The ſame ing muſt alſo happen in the Time of the poſitions of the ſuperiour Planets to the n, and particularly of that of *Mars*, which earer, and that of *Jupiter*, which is greater, which muſt, with his four *Satellites*, make ar greater Vortex: And theſe Effects muſt encreaſe, when ſeveral Planets, at the

ſame Time, are as near the Earth as they ca
be, ſo that all Things being otherwiſe equa
the greateſt Tides muſt be when all the Plane
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as is eaſy to comprehend.

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CHAP. XI.

Reflections on the Cauſes of the Variation of the Tide.

ONE might here add a great many Things highly probable in relation to the Subject of the Variation of Tides, as well as in reſpect of the different Combinations of thoſe we have ſpoken of, as they which the Curious may make themſelves. I ſhall content my ſelf only to ſay, *en paſſant*, that it is eaſy to ſee, that if a great number of Cauſes, and ſo different one from another, can be combin'd in ſo many different Manners, one muſt not be ſurpriz'd, if we cannot aſſure our ſelves of any Thing poſitive in relation to the Effects we obſerve by the Flux and Reflux of the Sea. But on the other Hand, this Diverſity of Combinations does not hinder, but by exact Obſervations made in Places proper for that Purpoſe, one might diſcover ſeveral Secrets of Nature, and

and make ſeveral Diſcoveries on the Subject of Celeſtial *Phyſicks*; there being nothing more to be done to effect this, than to take great Care of all the Circumſtances which accompany the Effects we perceive; ſo that in about ſome little Time, one might come to the Knowledge of all Things, by the Conformity of Effects, which might have relation almoſt always to the ſame Subject.

It would ſuffice for that, to eſtabliſh three Obſervators, one under the Torrid Zone, and two under the Temperate Zones. One of theſe two in the Northern Hemiſphere, and the other in the Southern; but one for all under the Torrid Zone, becauſe that is the Place where the celeſtial Cauſes are, which produce the Flux and Reflux of the Sea, and where the Variations of the Tides make themſelves more ſenſibly perceiv'd; becauſe they make their Efforts there more direct than under the Temperate; while on the other Hand, the Effects produc'd by the Air make there leſs Alteration, becauſe its Gravity then changes but a little, and beſides the Winds are there very weak, and always uniform, without the leaſt Variation. So that theſe Obſervations muſt be made more particularly under the Torrid Zone, if one would make any Diſcoveries by their Means, which is the only one whereby we may be aſſur'd of the Truth of *Phyſical* Conjectures.

The Places moſt proper to make theſe Obſervations, are towards the Capes, or in the little Iſles, becauſe they are leſs ſubject to the Variations of Tides proceeding from the Diſpoſition of the Coaſts of the Sea, or River-Waters. In ſhort, in relation to theſe Principles, it would be

be good to eſtabliſh Obſervations on the Coaſt of *Guinea*, toward *Cape Verd*, or the *White Cape*; or on the Coaſt of *Braſil*, about *Pernambuco*, another at the Cape of *Good Hope*, and a third near Cape *Finiſterre*, or towards that of St. *Vincent* in *Portugal*.

It would likewiſe be convenient that theſe Obſervations were continu'd for ſome Years, in order to have a great Number made in ſeveral and different Conſtitutions of the Planets; to confirm them, by comparing one with another, that one may not be deceiv'd in the Conſequences which we may draw from thence, in attributing Effects to a Thing which cannot be the Cauſe of them, as may happen if theſe ſame Effects were not confirm'd by Experiments, frequently repeated in the ſame Conſtitution of Planets.

To make theſe Obſervations with Advantage, it would be neceſſary, that every Obſervator mark exactly every Day and Night the preciſe Time of the high and low Tides, and to what Height they riſe and fall every Time. It would be alſo neceſſary, that the Obſervators mark, as near as poſſible, the Force and Direction of the Winds, with the Height of the Barometer, as is explain'd by the Plan herein before inſerted; that one may know if the Winds, or the Gravity of the Air, have not caus'd ſome Alteration in the Height of the Tides. It would be moreover very convenient to mark down, as near as poſſible, the Diſpoſition of the Place of their Obſervations, and thoſe of the neighbouring Coaſts, with the Depth of the Sea, becauſe of the Circumſtances which generally

generally accompany all theſe Things, as is herein before obſerv'd.

To make theſe Obſervations, it is not neceſſary that the Obſervators be Mathematicians, or underſtand Aſtronomy; it is ſufficient only, that the Journals of their Obſervations, made in the ſame Manner as has been ſaid, be made publick, that all the curious in Phyſicks, who underſtand the Courſe of the Planets, may make their particular Reflections in regard to all thoſe Things to which we have attributed the Variation of Tides: By this Means one might diſcover the Truth of all the Conjectures which we have here taken Notice of; and therewith one might make ſeveral fine Diſcoveries to bring to Perfection *Cœleſtial Phyſicks*, which is to us ſo much unknown, and of which one cannot have a more ſure and certain Knowledge, than what we may acquire by our Obſervations upon Tides.

The illuſtrious Society of *Paris*, call'd, *The Royal Academy of Sciences*, have already made a happy Beginning of theſe Obſervations, from whom one might promiſe ſomething advantagious, if they had continu'd on the ſame Footing, and under the Direction of as able an Aſtronomer as Monſ. *Caſſini*; eſpecially, if theſe Obſervations had been made under the Torrid Zone, which is, as has been ſaid, the moſt proper Place, becauſe leſs ſubject than all others to the Accidents of Weather.

The Remarks which Monſieur *Caſſini* has made on the Flux and Reflux of the Sea, are very juſt, and agree with the Conjectures which I have made in my Treatiſe of *Phyſicks*; but I believe he might be deceiv'd, when he ſai

ſaid, *That the ſmall Axis of the Vortex of the Earth is not always directed towards the Sun; becauſe it often happens that the Moon is nearer the Earth in the Quadratures than in the Zyzygies.* For it is ſufficient, that the Diſtance of the Movement of the Vibration of the Moon, or her anomalar Movement be greater than the Difference of two Semi-Diameters of her Oval Epicycle, to make the Moon ſometimes come nearer the Earth and the Quadratures than the Zyzygies, tho' the ſmall Diameter of the Vortex of the Earth, and by Conſequence of the Epicycle of the Moon, be always directed from the Side of the Sun; as it muſt naturally be, according to the Demonſtration which I have made in my Treatiſe of *Phyſicks*, which is founded on the natural Laws of the Movement of fluid Bodies.

N. B. *This Diſſertation having appear'd ſome Part in Manuſcript for ſome Time, Monſieur* Caſſini *has ſince chang'd his Opinion; as appears in the* Memoirs of the Royal Academy of Sciences.

After all theſe Conſiderations, I conclude, that the true Means of making fine Diſcoveries to perfect *Phyſicks*, is to eſtabliſh Obſervations, as they are herein above ſet down, in ſeveral Places; being perſwaded that this Affair would, by theſe Means be ſooner brought about, than by making Diſſertations or Syſtems upon ſuch Things which cannot otherwiſe be known than by Conjecture; becauſe, when the Subject of a Diſſertation or Syſtem is unknown, thoſe who make them are liable to be deceiv'd, as well as thoſe who muſt judge of their Validity. For, in order to judge whether Things are good or ill, it is neceſſary to be acquainted with

their Principles, which being ſuppos'd unknown, as moſt Part of *Phyſical* Cauſes are, theſe Encouragements or Gratuities would ſerve at moſt but to eſtabliſh Prejudices, which would be ever detrimental to the Progreſs of this Science; for, to make a good Progreſs in any Science, we muſt diveſt ourſelves of Prejudices, and be perſwaded that we not know the Thing we are in Search to diſcover, it being not poſſible that we can apply ourſelves to find out a Thing we believe we have a true Notion of, or dive into a Science we fancy our ſelves Maſters of.

Beſides, this would prevent a great many Impoſtors, who only endeavour at Rewards by confus'd Syſtems, of which there have been many Examples in theſe Provinces, upon the Subject of the *Diſcovery of the Longitude*. Thoſe who underſtand *Mathematicks*, as well as thoſe who have Experience in *Navigation*, would never apply themſelves to this vain Search of *Longitudes*, becauſe they know it is impoſſible to find them, as well as ſeveral other Things unknown.

But in relation to *Phyſicks*, that may be perfected by the Means of ſuch Obſervations as mention'd in this ſmall *Diſſertation*, which I have now finiſh'd, in repeating my Wiſhes, That ſome great Prince, or ſovereign Republick, or Society, would be excited to undertake theſe Obſervations, which in a great many Things would be very uſeful and advantageous. If the illuſtrious Academy of *Leyden* would undertake this ſmall and agreeable Trouble, I doubt not but it would tend more to illuſtrate it, and add ſome ſmall Degree to their high Reputation.

F I N I S.

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